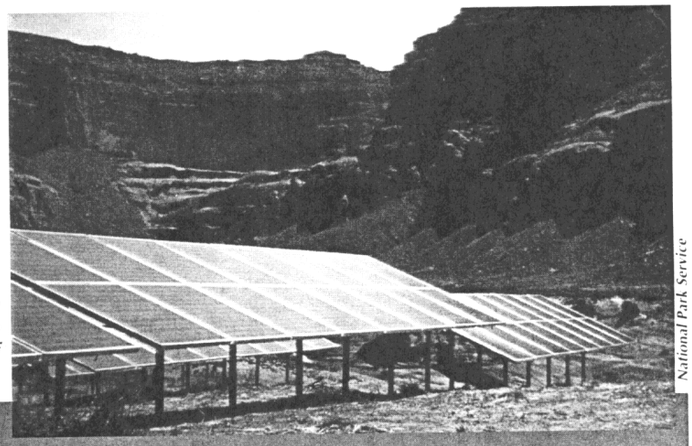
Renew the Parks

Sustainability is the driving force behind a proposal for 640 new energy projects in America's national parks

BY LINDA R. BROWN



National Park Service

The Dangling Rope Marina in Utah's Glen Canyon National Recreation Area recently installed this 115-kilowatt photovoltaic system to eliminate the use of more than 65,000 gallons (246,000 liters) of diesel fuel every year.

Until last year, the Dangling Rope Marina at Lake Powell ran the risk of a miniature Exxon Valdez fuel spill every 10 days. The isolated marina required more than 65,000 gallons (246,000 liters) of diesel fuel annually to run its electricity–producing generators—and the only way to transport the fuel was by barge.

As the result of partnerships with the U.S. Department of Energy, the marina has replaced its diesel generators with a sleek new 115–kilowatt photovoltaic system complete with battery storage and propane backup. The savings over the next 20 years are impressive—more than $2.3 million in fuel costs and the elimination of more than 25 million pounds (11,340,000 kg) of air pollutants. In addition, the switch to renewable energy eliminated the risk of fuel spills that could cost several hundred thousand dollars to clean up.

National Park Service

The Dangling Rope Marina is one of 370 sites maintained by the National Park Service, which has declared its intention to become a world model of sensitive environmental management and sustainable design.

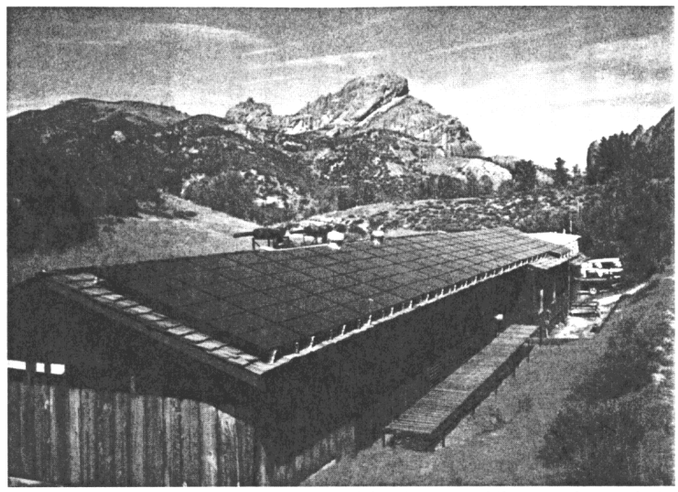
"An important part of this strategic plan is to achieve sustainability—to preserve the parks in a way that leaves them unimpaired for future generations," said Douglas DeNio, a park service engineer who spearheads the Renew the Parks program. "One of the main components of sustainable design is energy management."

In 1994, the park service teamed up with the U.S. Department of Energy's (DOE's) Sandia National Laboratory to conduct a survey of existing photovoltaic systems and assess the potential for future projects. The survey had some surprising results—as many as 600 photovoltaic systems were already in use in the national park system, primarily for small applications such as powering outdoor lights, restroom ventilation and communication devices. Park personnel reported that about 97 percent of these systems were operating in a satisfactory manner. When asked for suggestions for future projects, park staff responded with a whopping 643 proposals totaling $28 million. Three of the proposed projects—for remote facility power in Glen Canyon—carry price tags of more than $1.7 million apiece.

"It's a snowball effect," DeNio said. "Once we got some systems up and running, they sold themselves."

More than 20 of the proposed projects are now completed or underway. Funding is arranged on a case-by-case basis, primarily in partnership with the DOE's Federal Energy Management Program, Sandia National Laboratories, the National Renewable Energy Laboratory, state energy offices and local utilities.

The park service now makes all development decisions based on life-cycle cost analysis, which places a monetary value on many of the hidden costs of conventional energy use such as air pollution and fuel spill cleanup. Projects that eliminate the use of existing diesel generators take priority, and high priority goes to projects that provide power for remote sites currently lacking electricity. Grid-tied applications where excess electricity can be sold back to the local utility are also being considered.



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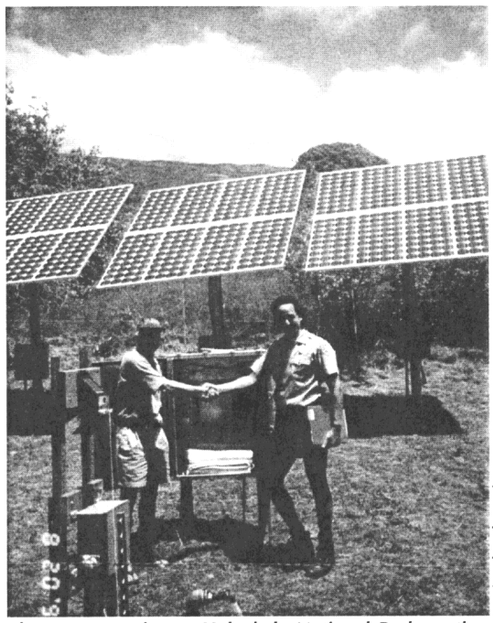
At Pinnacles National Monument in California, a 9.6-kilowatt photovoltaic system provides power for three employee residences, a ranger station, visitor center, campground, comfort station, well pump and two wastewater effluent pumps.



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The ranger station at Haleakala National Park on the island of Maui has its own source of potable water for the first time thanks to this 2-kilowatt photovoltaic system installed last year.

Clean, Quiet Energy

Perhaps the most successful new project is the overhaul of energy management at the Pinnacles National Monument in California. Until last year, diesel generators supplied power for three employee houses, a ranger station, visitor center, comfort station, campground, well pump and two effluent wastewater pumps. The generators ran constantly, gobbling up more than $20,000 a year in fuel and producing huge amounts of both air pollution and noise.

"The constant din could be heard from the residences, offices, work spaces, trails and even the surrounding peaks," said superintendent Gary Candelaria. "The use of finite fossil fuels to inefficiently produce electricity...the lasting impact of air pollution on the environment...the machinery and exhaust noise impacts on the wilderness qualities of solitude and silence—these were prices we became unwilling to pay."

With the help of Sandia National Laboratories, the Pinnacles replaced its diesel generators with a 9.6-kilowatt roof-mounted photovoltaic system with battery storage and propane backup. Improvements to energy efficiency include replacement of air conditioners with swamp coolers and improved lighting systems. The combined efforts reduced energy use from about 100 kilowatt-hours per day to less than 40, and virtually eliminated all noise and air pollutants associated with meeting the energy needs of this remote area of the monument.

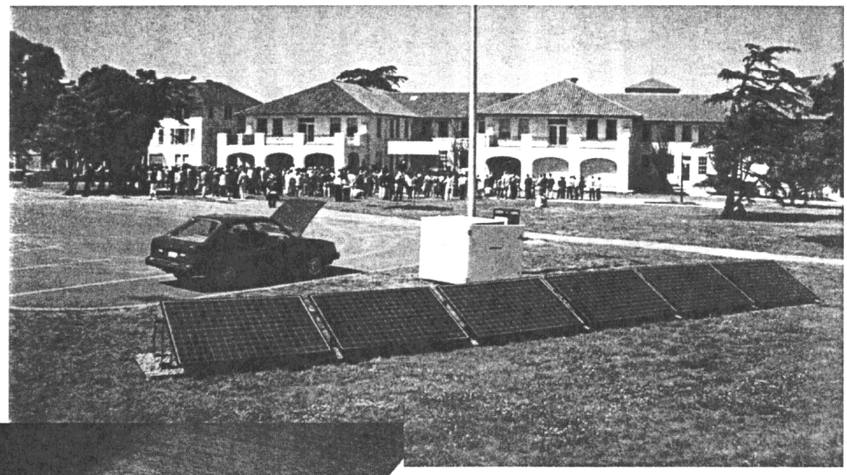
Counting the Cost

With a total price tag of about $160,000, the Pinnacles project has an estimated payback period of less than five years.

"The payback period depends on what you consider," said DeNio. "If you consider the usual simple payback of capital cost and fuel savings, you're looking at maybe 8 years. If you consider air emissions, the payback period comes down to 6 or 7 years. If you factor in fuel spill cleanup it's down to 5 years. And if you add in factors such as reduced noise and the opportunity for public education, you're down to less than 5 years."

The park service includes all of these factors in its development decisions. "Hard costs" are easy to quantify—for example, the installed cost of a photovoltaic system when compared to a conventional power line extension (which can run as high as $20,000 per mile in rugged terrain, plus ongoing costs for maintenance and repair). "Soft costs" such as emissions are not quite as easy to quantify, but are no less important when power production is so closely tied to environmental preservation.

According to DeNio, the average installed cost of photovoltaic systems has been about $16,000 to $17,000 per kilowatt. This includes design, purchase, installation of the photovoltaic system as well as balance-of-system components such as battery storage, inverters and propane backup generators. Energy costs for photovoltaics currently average about 25¢ per kilowatt-hour. This may seem extravagant to utilities that are paying $700 per kilowatt for natural-gas-fired capacity and incurring energy costs of 2 to 3 cents per kilowatt-hour. However, complete life-cycle analysis makes renewable energy more than competitive with conventional utility power for many park applications. For example, Lassen Volcanic National Park recently analyzed options to revamp the power supply to five restrooms in a relatively remote location. Analysis showed that photovoltaics would be more than 10 times cheaper than the local utility's estimate for reconstructing the existing power system.



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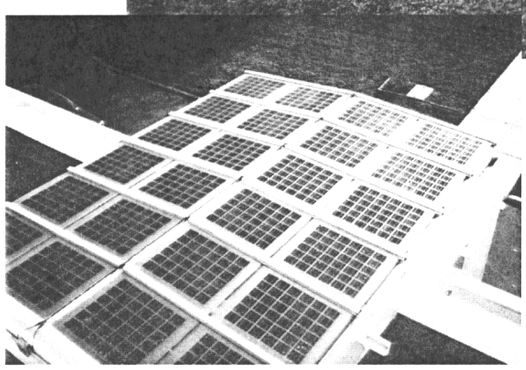


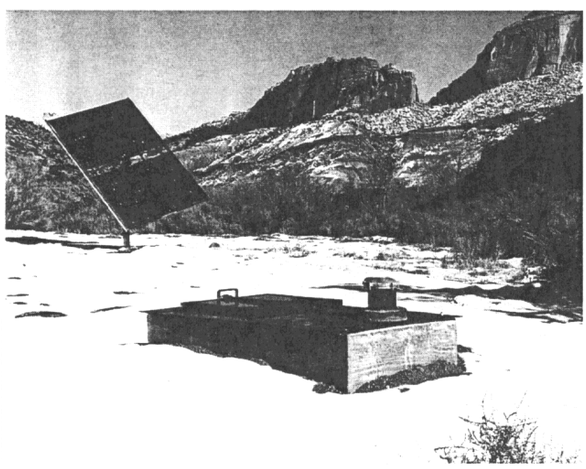
National Park Service

Some unusual features of the Presidio project in San Francisco include a skylight that generates electricity and a portable photovoltaic system that can be used to recharge electric vehicle batteries.

When compared to the complete cost of diesel-generated power, the savings are even more impressive. According to DeNio, the cost of diesel-generator power is about 25¢ to 30¢ per kilowatt-hour if the fuel can be trucked into the area. When the fuel must be barged into isolated areas such as Dangling Rope, the cost can skyrocket to as much as $1.80 per kilowatt-hour. In addition, experience has shown that the efficiency of diesel generators is extremely low, primarily because they must be operated at a constant 40 percent capacity to maintain a stable power supply. Park service personnel at the Pinnacles often left electric lights and appliances turned on 24 hours a day to create the necessary load—a necessity that tripled the price of diesel-based power.

The park service also includes the cost of emissions in its life-cycle costing. Monetary values are an attempt to quantify the hidden costs of energy production and use such as acid-rain damage to forests. Carbon dioxide emissions are valued at $8.00 per ton, with sulfur dioxide emissions valued at $0.75 per pound and nitrous oxides at $3.40 per pound. For comparison to conventional utility-generated electricity, the park service uses a state-by-state breakdown of electricity costs and emissions based on the average fuel mix for that area. Renewable energy technologies such as photovoltaics and wind produce zero emissions and therefore have zero emissions costs.

The most arbitrary costs in the park service's analysis are associated with aesthetics and the opportunity for public education.



National Park Service

The National Park Service is considering almost 80 proposals for photovoltaic-powered well pumps such as this one at Capitol Reef National Park.

DeNio admits that it's hard to place a monetary value on things like aesthetics. Even so, aesthetics play a major role in energy development decisions for the park system. For example, to some park personnel, wind machines represent an intrusion on the natural beauty of pristine areas. Photovoltaic systems, on the other hand, can be integrated into the rooflines of existing buildings or hidden from view by a row of tall bushes or trees.

But compromises are possible. For example, personnel at Channel Islands National Park off the coast of California decided to make use of excellent wind resources in that location by installing a wind-photovoltaic hybrid system with propane backup. Engineers were able to design a smaller, less obtrusive—and less expensive—system by reducing the facility's power requirements with energy efficiency retrofits.

Lastly, public education about renewable energy is valued at about a dime a visitor. More than 270 million visitors visit the park system every year, and the cost of the proposed energy projects totals about $28 million.

Applying the technologies

Other projects now completed or underway illustrate the diversity of renewable energy and energy efficiency options.

At Salinas Pueblo Missions near Albuquerque, New Mexico, a grid-tied photovoltaic system provides power to a 2000-square-foot (186 m^2) visitors center and 800-square-foot (74 m^2)comfort station. Excess power is sold back to the local utility. As with the Pinnacles project, power

Exemplary Living at the Grand Canyon

The recently completed environmentally friendly "exemplary home" at Grand Canyon National Park is the result of almost 20 years of buildings research. Designed by engineers at the National Renewable Energy Laboratory in conjunction with park service personnel, the home combines energy efficiency with state-of-the-art passive solar technology to achieve a 75 percent reduction in energy use compared with a conventional home.

"The occupants say they're very satisfied with the home's performance," said Todd Alexander, project manager for the National Park Service. "Utility bills averaged about $100 a month in December, January and February. Some of the other new homes nearby paid as much as $300 per month depending on the number of occupants and their lifestyle."

The exemplary home features a glazed Trombe wall that captures and stores the sun's heat for slow, even release at night. On hot summer days, the Trombe wall keeps the home comfortably cool by intercepting the sun's heat. Clerestory windows bring natural daylight into the living space, reducing the need for energy-consuming electric lights. R-50 ceiling insulation, R-34 walls and an insulated concrete pad are part of an ultra-air-tight building envelope that reduces air leakage by 60 percent when compared to conventional construction. A waste heat recovery system captures heat from the ventilation system and uses it to warm the water for laundry, showers and kitchen.

NREL

Designed by NREL researchers, this 1300-square-foot (121 m²) home combines energy efficiency with passive solar features to reduce energy.

"This is an integrated building design—one that considers all aspects of how a building uses energy," explains Paul Torcellini, head of NREL's exemplary buildings research program. "Typically, exemplary homes will cost about the same to build as conventional homes. Upfront design costs are a bit higher, but homeowners quickly recover the extra cost through energy savings."

Existing passive solar designs reduce home energy use by about 40 percent. Advanced technologies such as those demonstrated at the Grand Canyon have the potential to slash residential heating bills by as much as 95 percent and lighting bills by 80 percent.

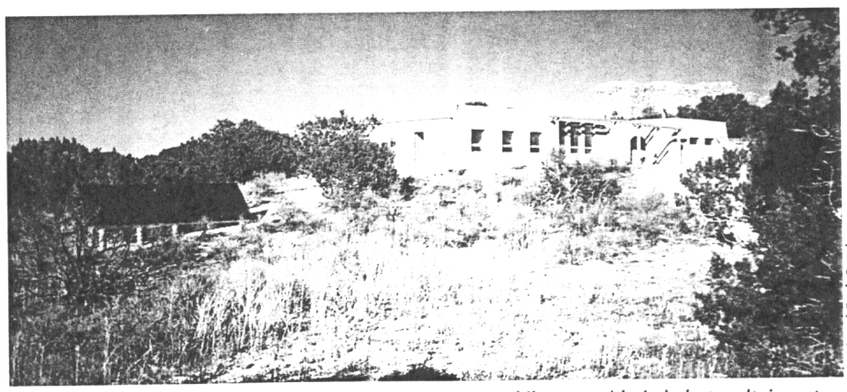
requirements are reduced by the use of energy efficiency technologies. Recycled styrofoam was used to construct R-50 walls for the slab-on-grade buildings. Other energy-saving features include passive solar orientation, daylighting, highly efficient lights and electronic ballasts, exterior shades over south-facing windows and water conserving appliances (which reduce electricity use for the well pump).

At Haleakala National Park on Maui, a two-kilowatt photovoltaic system now pumps water for the ranger station and visitors center. Grand Canyon National Park is making the switch to electric vehicles, and may install a photovoltaic recharging station in the future. The Presidio in San Francisco has several unusual applications for photovoltaic—such as a skylight that generates electricity—in addition to energy efficiency measures installed with the help of DOE's Federal Energy Management Program. Sleeping Bear Dunes in Michigan has operated a photovoltaic-powered well pump for several years and recently added facility power as well.

Other large applications of energy efficiency and renewable energy have been proposed for Capitol Reef, Crater Lake, Rocky Mountain National Park, Great Basin, Yosemite and Wrangell-St. Elias.

DeNio points out that the success of existing systems will be a critical factor for continued support of renewable energy projects. Recent budget cutbacks make funding for future projects scarce. However, the survey conducted in 1994 and the satisfaction of many park personnel paint a hopeful picture for support of sustainable energy in America's national park system.

"The system works, it is practical, and it is sustainable," said Pinnacles superintendent Candelaria. "Within two years of deciding that change was necessary, we have a functioning hybrid photovoltaic system producing clean power with scarcely a second thought being paid to it anymore. Now, more than ever before, Pinnacles National Monument is a place where natural forces are still at work shaping the land and its people." ✪



National Park Service

At the Salinas Pueblo Missions National Monument, a 1.5-kilowatt grid-tied photovoltaic system provides 60 to 70 percent of the power required by the visitor center and comfort station.